Grid Modernization Initiative

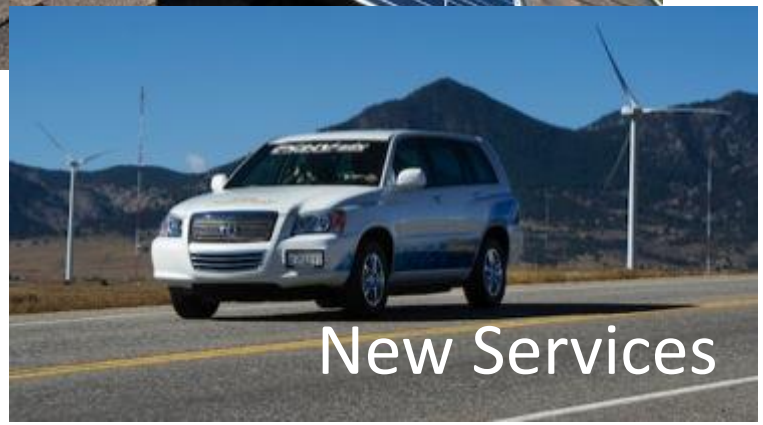
Kevin Lynn, Office of Energy Efficiency and Renewable Energy

October 22, 2015

Why Grid Modernization?

The existing U.S. power system has served us well…

but our 21st Century economy needs a 21st Century grid.



Trends: Moving from the 20th Century to the 21st Century

The structure of the 20th century grid, however, cannot meet all the demands of the 21st century. Five key trends are driving this transformation:

- A changing mix of types and characteristics of electric generation
- Growing demands for a more resilient and reliable grid
- Growing supply- and demand-side opportunities for customers to participate in electricity markets
- The emergence of interconnected electricity information and control systems
- An aging infrastructure

These forces challenge the capacity of the grid to provide us with the services we need, but they also provide us with the opportunity to transform our grid into a platform for greater prosperity, growth, and innovation.

Grid Modernization Vision

The future grid will solve the challenges of seamlessly integrating conventional and renewable sources, storage, and central and distributed generation. It will provide a critical platform for U.S. prosperity, competitiveness, and innovation in a global clean energy economy. It will deliver ***resilient, reliable, flexible, secure, sustainable,*** *and* ***affordable*** *electricity to consumers where they want it, when they want it, how they want it.*

Achieve Public Policy Objectives

- 80% clean electricity by 2035
- State RPS and EEPS mandates
- Access to reliable, affordable electricity
- Climate adaptation and resilience

Sustain Economic Growth and Innovation

- New energy products and services
- Efficient markets
- Reduce barriers for new technologies
- Clean energy jobs

Mitigate Risks and Secure the Nation

- Extreme weather
- Cyber threats
- Physical attacks
- Natural disasters
- Fuel and supply diversity
- Aging infrastructure

GMI's Integrated Technical Thrusts

Institutional Support	• Provide tools and data that enable more informed decisions and reduce risks on key issues that influence the future of the electric grid/power sector
Technology Innovation: Design and Planning Tools	• Create grid planning tools that integrate transmission and distribution and system dynamics over a variety of time and spatial scales
Technology Innovation: System Operations, Power Flow, and Control	• Design and implement a new grid architecture that coordinates and controls millions of devices and integrates with energy management systems
Technology Innovation: Sensing and Measurements	• Advance low-cost sensors, analytics, and visualizations that enable 100% observability
Technology Innovation: Devices and Integrated System Testing	• Develop new devices to increase grid services and utilization and validate high levels of variable generation integrated systems at multiple scales
Technology Innovation: Security and Resilience	• Develop advanced security (cyber and physical) solutions and real-time incident response capabilities for emerging technologies and systems

Impacts on Renewable Power

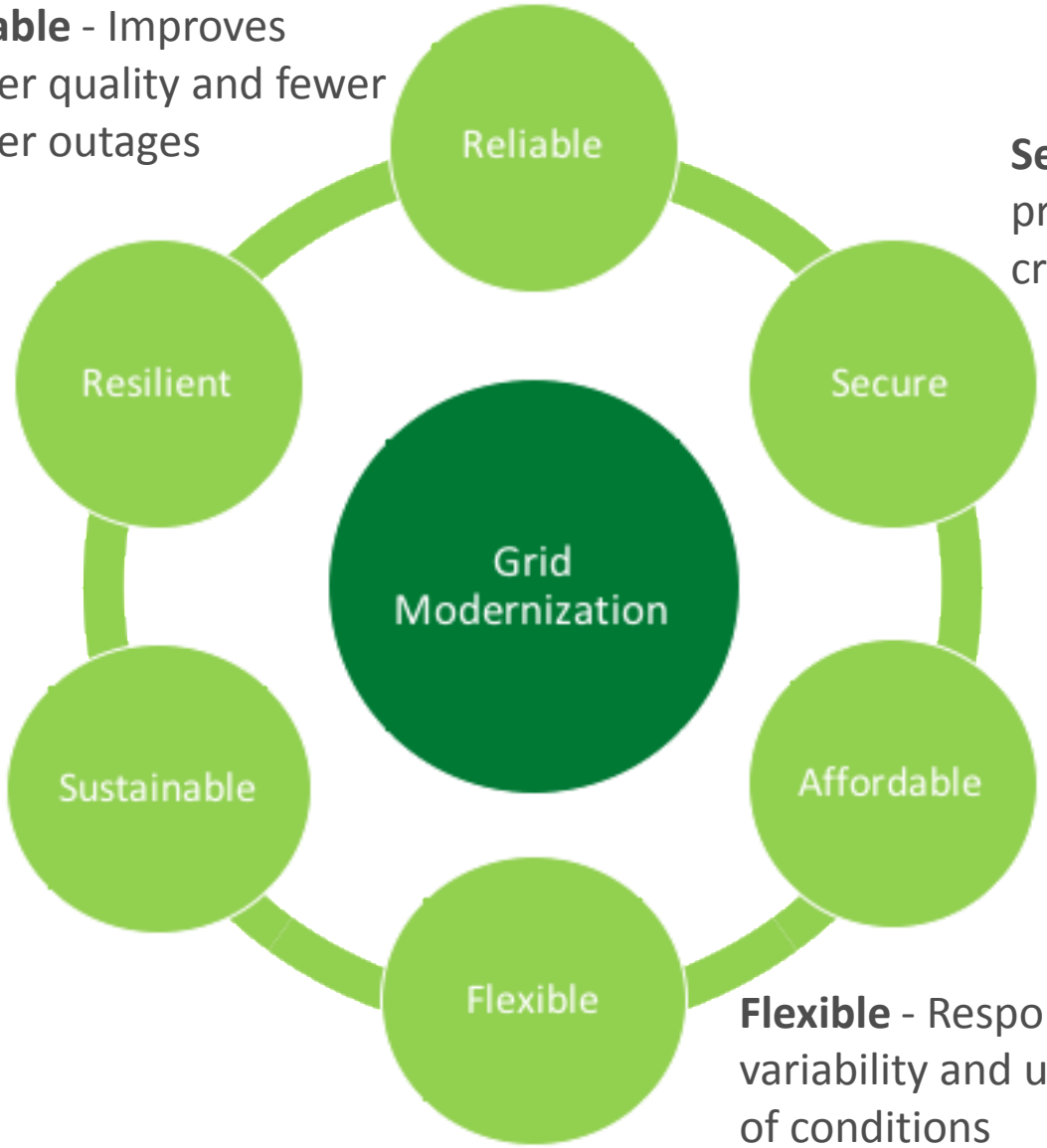
Institutional Support	• Provide tools and data that enable regulators to understand the implications of high penetrations of solar installed behind the meter
Technology Innovation: Design and Planning Tools	• Create grid planning tools that help utilities and other stakeholder plan for a system with high penetrations of wind, solar and geothermal systems.
Technology Innovation: System Operations, Power Flow, and Control	• Better wind and solar forecasts improve operators ability to predict when solar and wind will (and will not) supply power to the grid reducing the need for excess reserves.
Technology Innovation: Sensing and Measurements	• Better visibility into the distribution system will more clearly indicate where and when challenges with high penetration solar occurs.
Technology Innovation: Devices and Integrated System Testing	• Develop new devices to increase grid services that enable the utilization and validate high levels of variable generation integrated systems at multiple scales
Technology Innovation: Security and Resilience	• Develop advanced security (cyber and physical) solutions for behind the meter solar as it continue to become more prevalent.

Key Attributes of a Modernized Grid

Reliable - Improves power quality and fewer power outages

Secure - Increases protection to our critical infrastructure

Resilient - Quick recovery from any situation or power outage

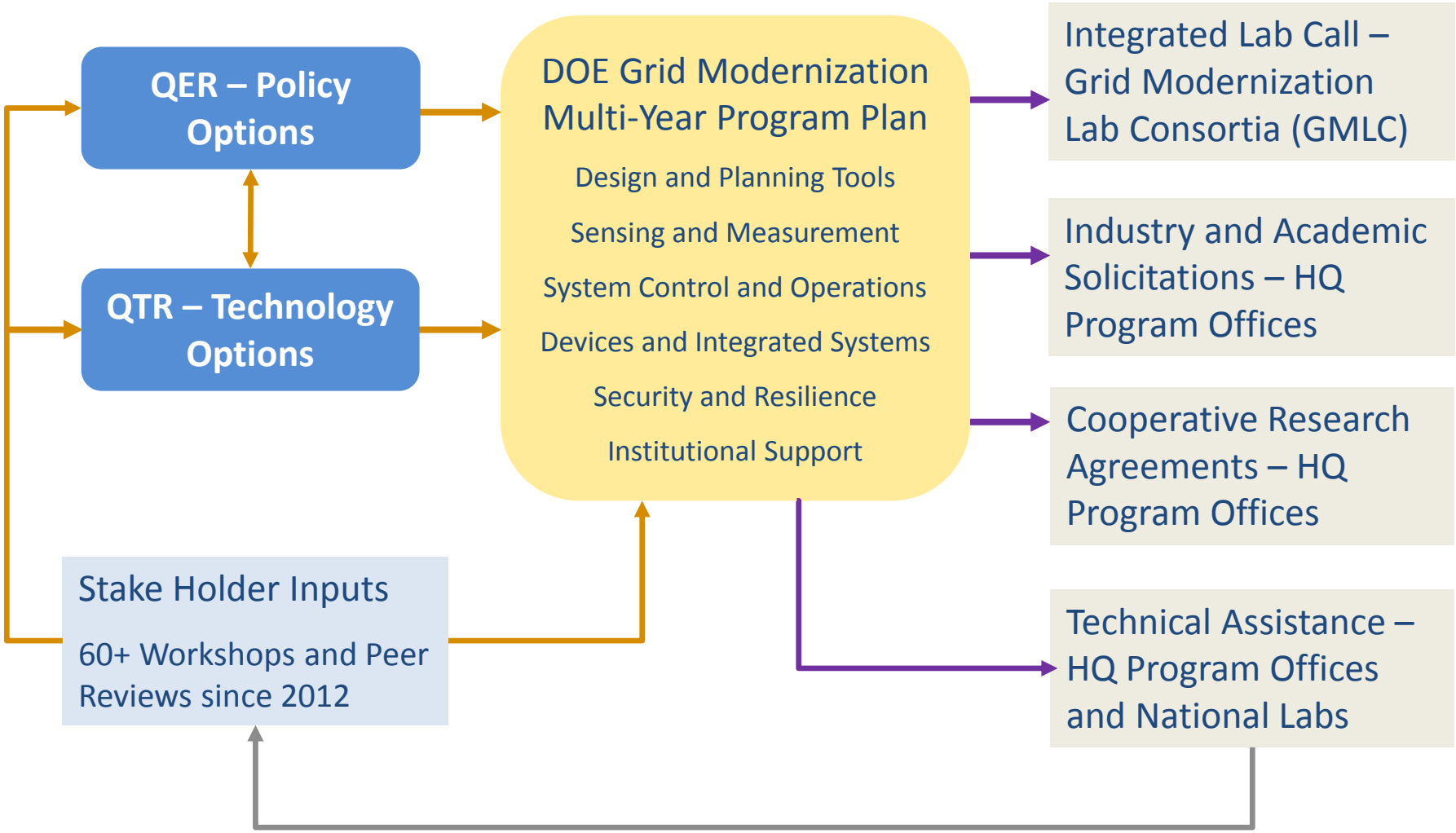


Affordable - Maintains reasonable costs to consumers.

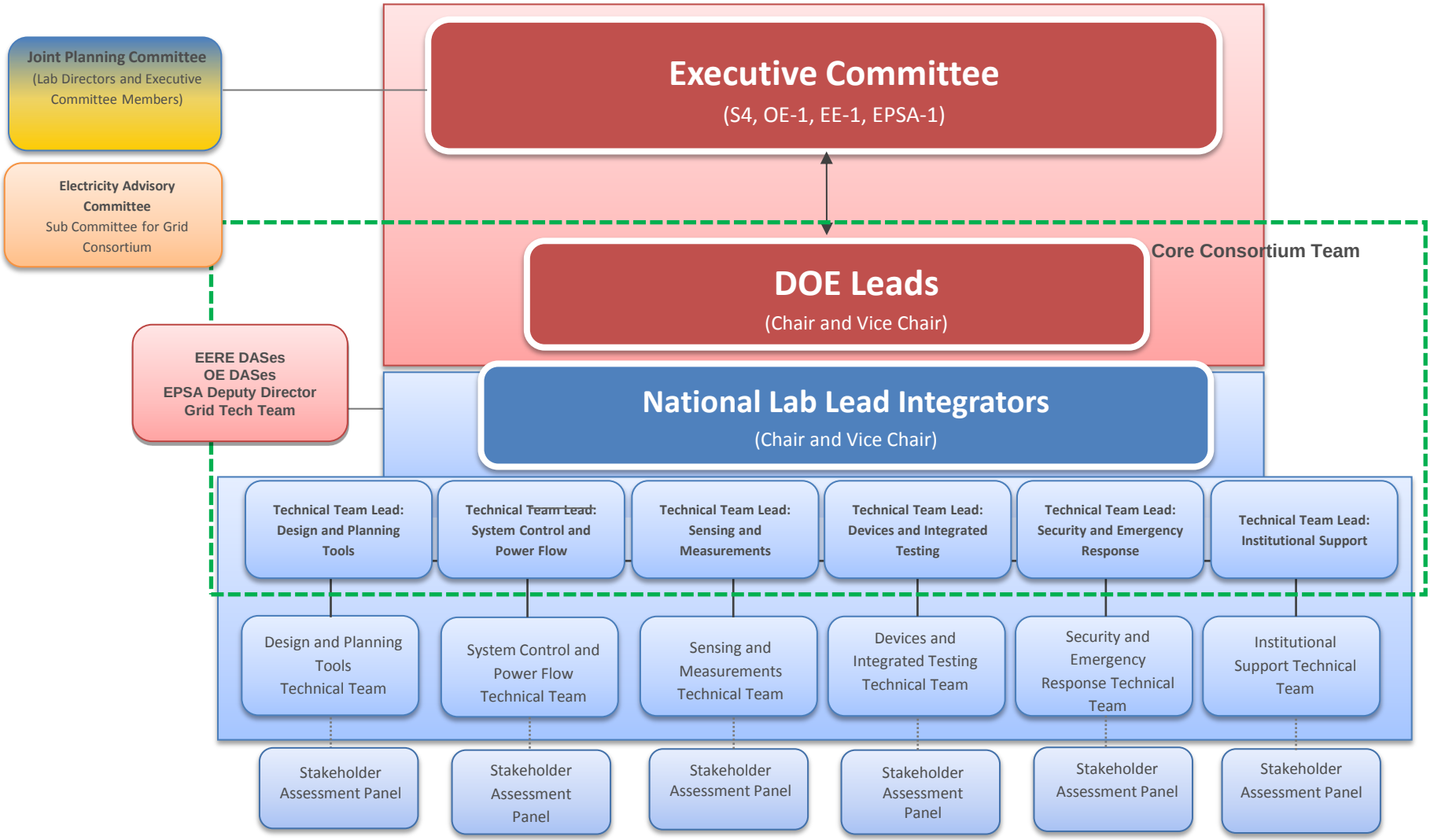
Sustainable - Facilitates broader deployment of clean generation and efficient end use technologies

Flexible - Responds to the variability and uncertainty of conditions

Connectivity to Other DOE Activities



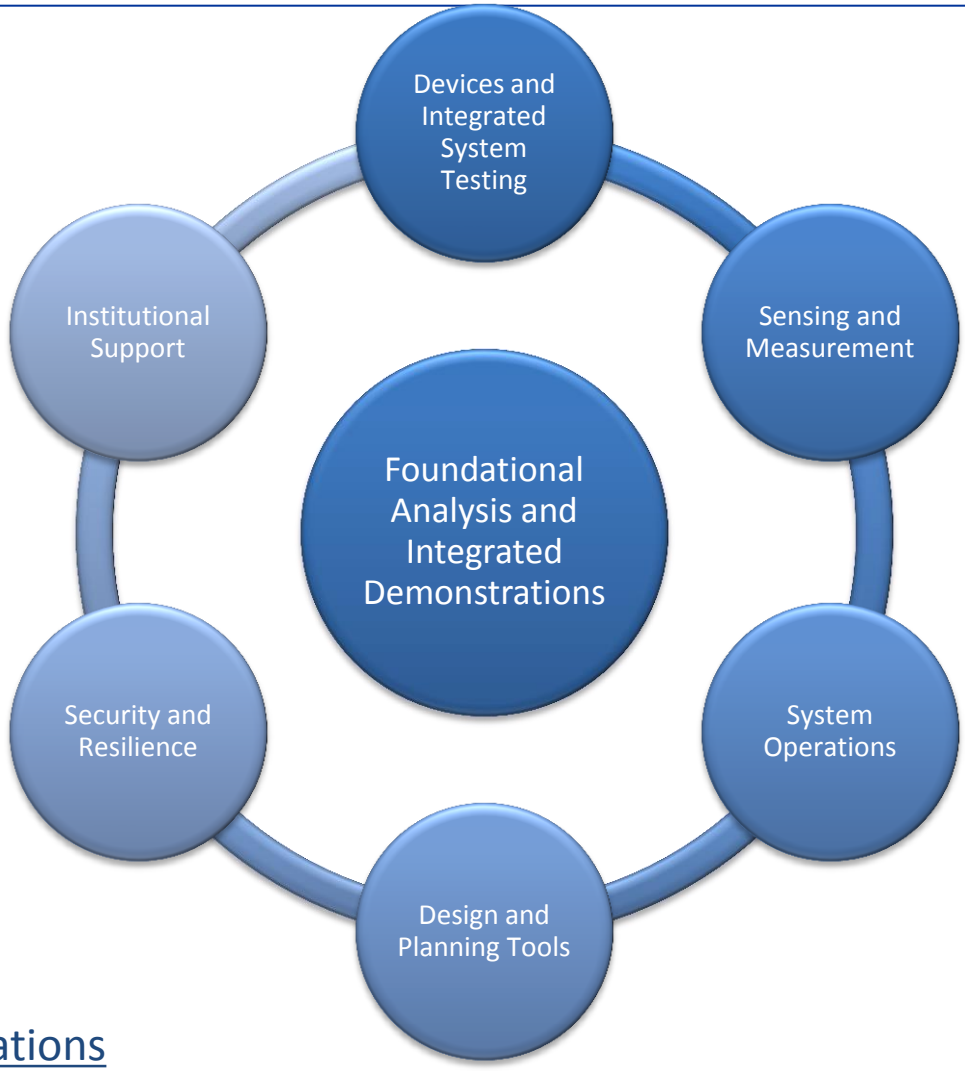
Grid Modernization Laboratory Consortium



DOE Grid Modernization Lab Call

Topic Areas

- Foundational Analysis for GMLC Establishment/Framework
- Core Activities
- Pioneer Regional Partnerships
- Foundational Technical Areas

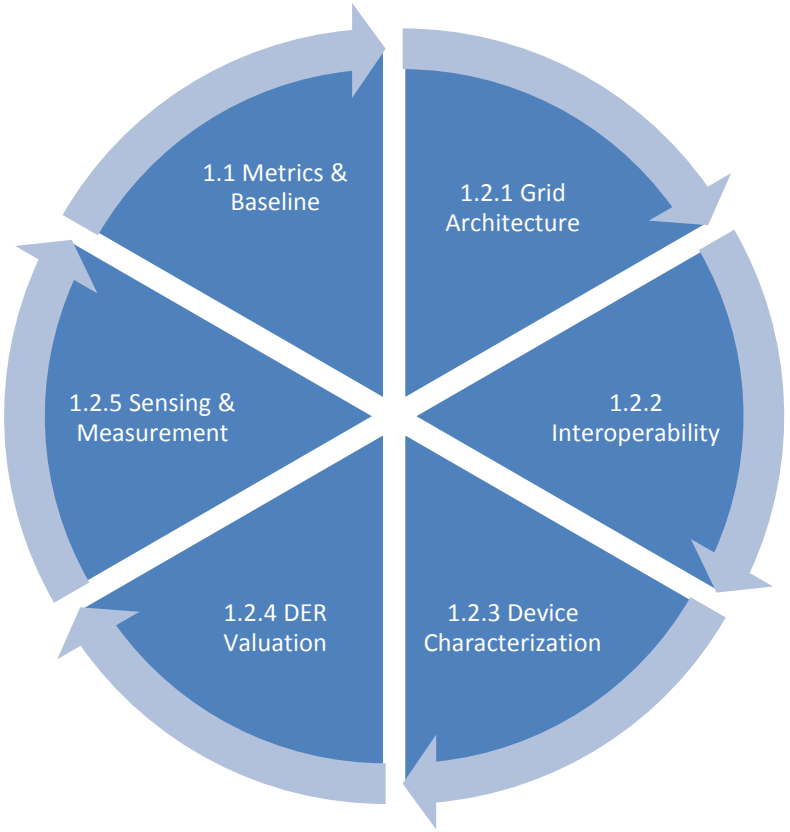


GMI Multi-Year Program Plan and Lab Call
http://www.netl.doe.gov/business/solicitations
Select: **2016GMLabCall**

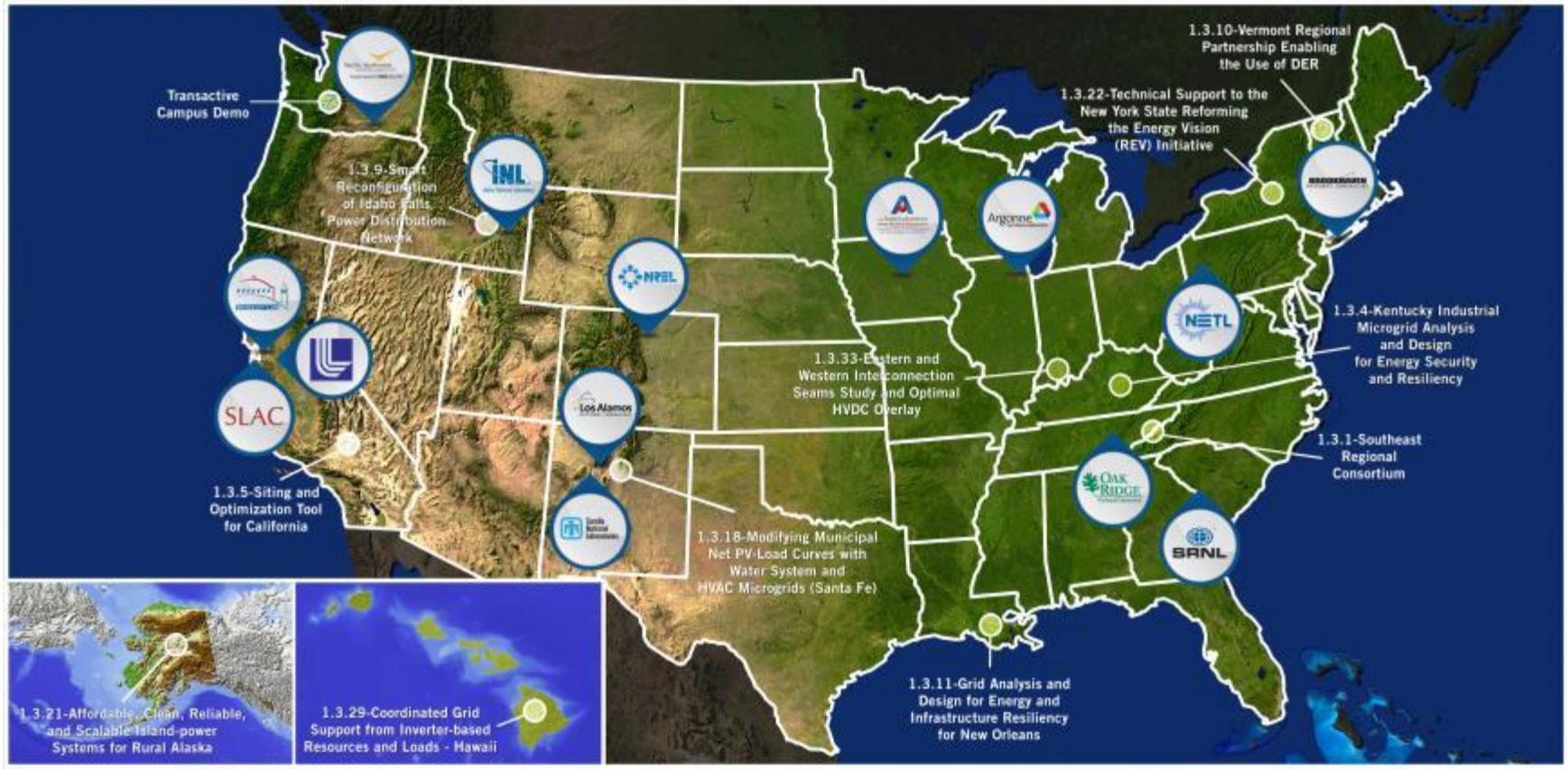
Core Activities

The Foundational Research projects provide the fundamental knowledge, metrics, and tools needed to support all the Cross-Cut R&D and regional partnerships. These three-year projects have interdependencies with one another and with the ongoing work of the DOE programs. They are designed to provide a fully integrated foundation of knowledge and analytic frameworks to enable an integrated DOE grid modernization strategy, including:

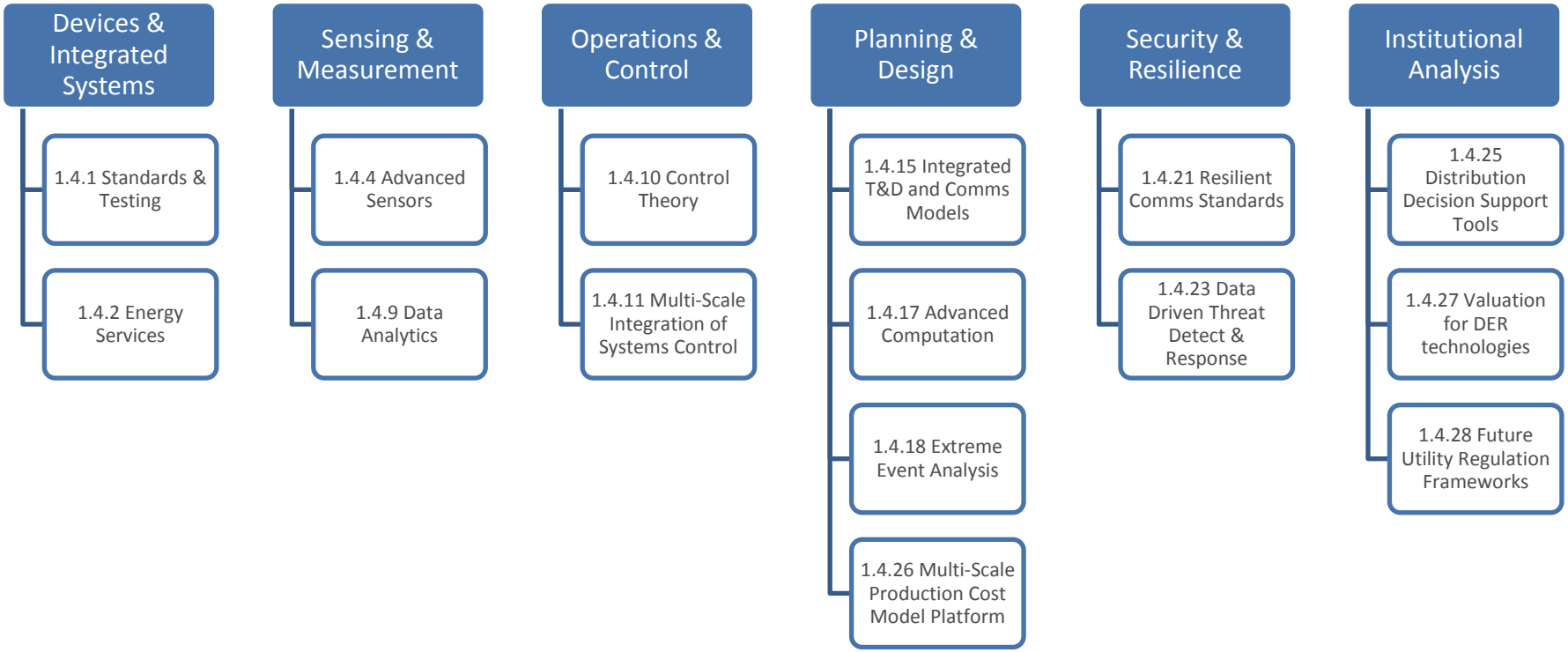
- fundamental metrics to guide and evaluate national progress in grid modernization;
- future grid and industry design elements to guide consideration of new industry paradigms;
- standards and protocols for interoperability and testing of all grid devices from high voltage to customer premises;
- an integrated testing network that spans the National Labs as well as industry and academia;
- a consensus framework for valuing emergent grid technologies and services; and
- a strategy for observing and monitoring the future grid system in a way that meets expectations for predictive control, real-time operations and security.



Grid Modernization Lab Call: Proposed Pioneer Partnerships



Crosscutting R&D

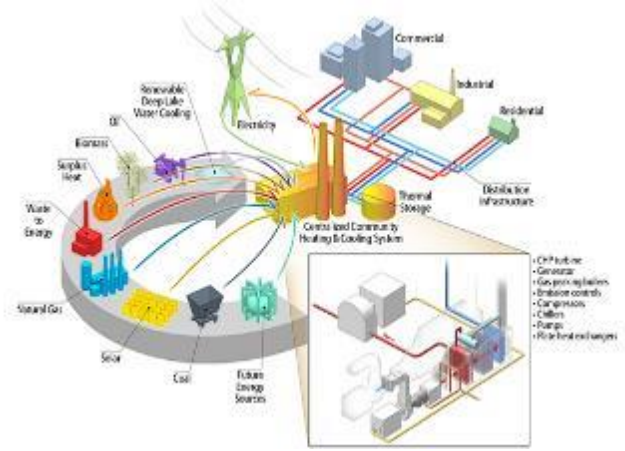


DOE Major Achievements—Demos

- **Major Achievement #1 – Lean Bulk Power Systems**
  - **Reliable**: Maintain reliable operations with a 10% transmission reserve margin or lower
  - **Affordable:** New operations capability for grid operators to safely run system closer to “edge” for increased asset utilization and to leverage distribution-level grid services will require less generation reserve
  - **Secure:** Incorporate advance physical and cyber security measures for the integration of large numbers of devices. Deploy predictive operations tools to detect and mitigate risk in real-time.
  - **Clean**: Real-time tools enhance wind resources with highe transmission asset utilization and management of system dynamics. Leverage of demand reduces emission from standby generation.
  - **Resilient**: Reduce outages by order of magnitude with improved prediction, detection, and distributed controls

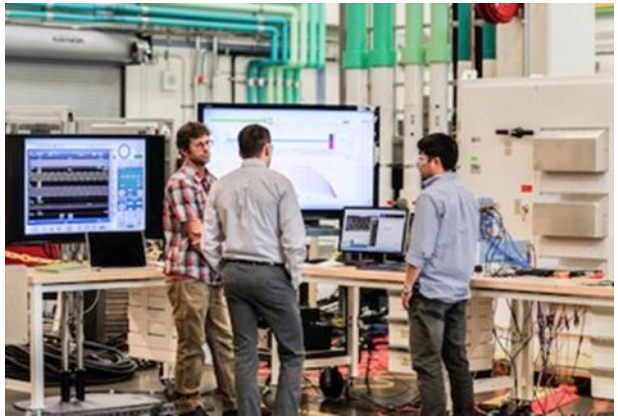
DOE Major Achievements (continued)

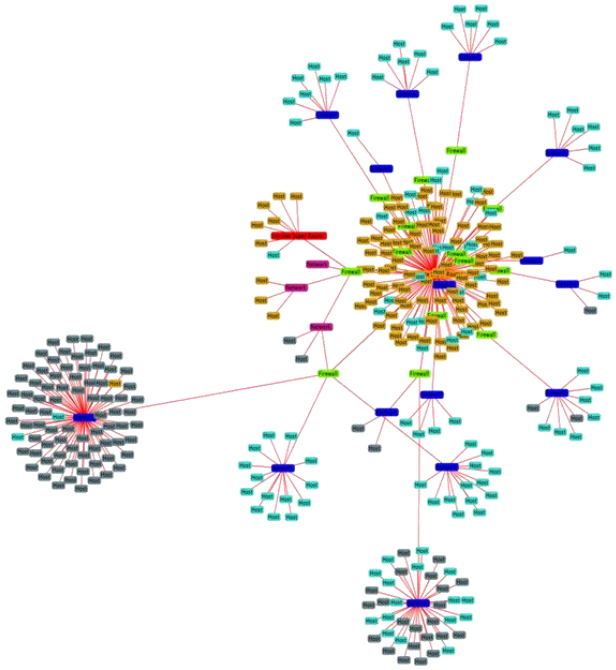
- **Major Achievement #2 – Clean Distribution Systems**
  - **Reliable & Resilient**: Coordinated microgrids control for resilience (e.g., 20% fewer outages, 50% shorter recovery time)
  - **Affordable**: Distributed, hierarchical control for clean energy and new customer-level innovation for asset utilization
  - **Secure:** Cyber resilient design of responsive loads and controls. Automation for outage detection and topology awareness for state estimation.
  - **Clean**: Demonstrate reliable and affordable feeder operations with greater than 50% DER penetration. Engage interactive efficiency concepts in buildings.



DOE Major Achievements (continued)

- **Major Achievement #3 – Grid Planning and Analytics**
  - **Reliable & Resilient**: Use coupled T&D grid planning models with 1000x speed-up to address specific grid issues
  - **Affordable**: Work with States to more rapidly evaluate new business models, impacts of policy decisions
  - **Secure:** Ensure high-level cybersecurity for all data-driven and operational models
  - **Clean**: Develop with stakeholders new data-driven approaches to DER valuation and market design





Requests

- Comments on the MYPP
- Participation in Technical workshops